Space Weather Technical Forecast

Issued on Wednesday, 29 June 2022 at 13:15 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

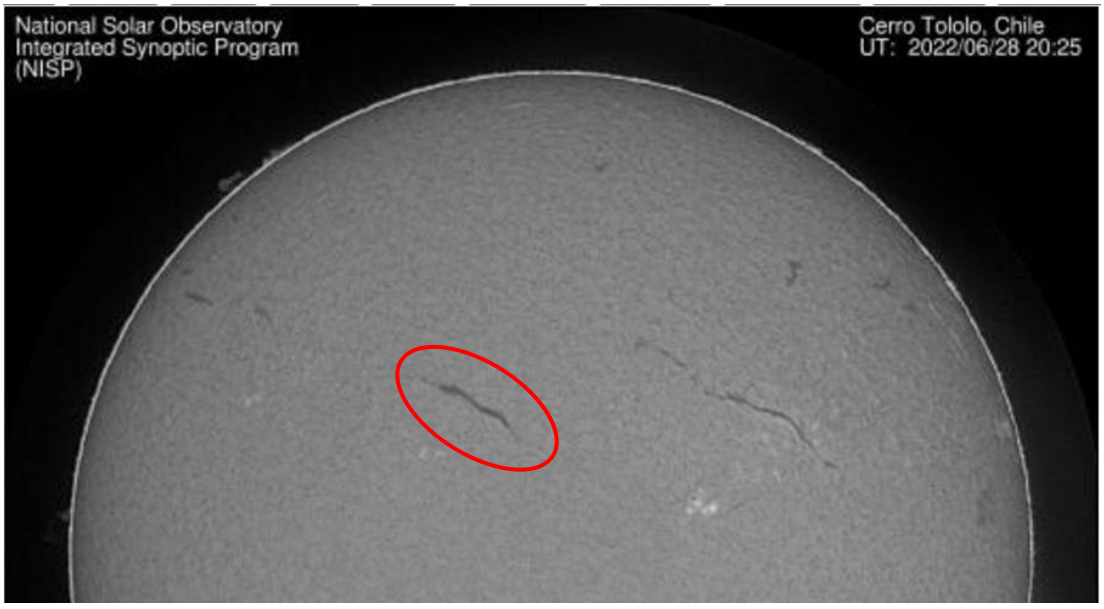
Space Weather Forecast Headline: Active electron fluence continuing. Slight chance of M-class flares.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Very Low over the past 24 hours, with no significant flares observed. There are five sunspot regions on the visible disc. AR3040 remains the largest region and although it appears largely inactive, a couple of spots have developed to the north of the main leader, from both positive and negative polarity. The group is now considered as Cao/Beta-Gamma. AR3041 has now rotated off the visible disc and has been removed from analysis. The other regions are small and unipolar groups.

A filament lift-off was observed originating from the northern centre disc at around 28/2200 UTC. The results of the analysis are not fully known yet but it is considered to be slow.

Figure 0: GONG H-Alpha image from Cerro Tololo, showing the filament responsible for the most recent CME, just before it lifted off.



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Solar Wind / Geomagnetic Activity: The solar wind speed, as measured by DSCOVR and ACE at L1, was largely elevated, around 500-550 km/s, but started to ease from 29/0600 UTC as the influence from a coronal hole high speed stream subsided. Density was mainly average. The Phi angle was predominately negative (towards the Sun) but became neutral or slightly positive (away from the sun) after 29/0600 UTC. The total Interplanetary Magnetic Field (IMF) was weak and below 6nT, the North-South component, Bz, fluctuating between +/-5nT. The resulting geomagnetic activity was largely Quiet with one Unsettled (Kp 3) interval between 28/2100-2400 UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV) as measured by GOES16 remained at Background levels throughout the period. The High energy electron flux (greater than 2MeV) was High initially, peaking at 4930 pfu at 28/1515 UTC, but dropped after 28/2200 UTC, fluctuating erratically between moderate and high levels. The corresponding 24-hour electron fluence remained above the Active threshold (1e8 integrated pfu), reaching a peak of 2.36e8 integrated pfu at 28/2100 UTC but started to decline thereafter. An observed fluence of 2.3e8 integrated pfu was recorded at 29/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to be Low or Very Low, with only a slight chance of isolated M-class flares.

Solar Wind / Geomagnetic Activity: A very slow CME which left the Sun on the 26th June may arrive at Earth on the 2nd July (Day 4). Another CME was observed leaving the sun at around 28/2200 UTC, this time originating from a filament lift-off in the northern centre disc. The results of the analysis are not fully known yet but it is considered to be slow. No other earth-directed CMEs currently feature in the forecast. Solar winds are expected to ease towards slow-ambient levels, with no significant enhancements expected during the rest of the period. Geomagnetic activity is expected to be mainly Quiet with isolated Unsettled intervals.

Energetic Particles / Solar Radiation: In the absence of any significant sunspot development, the High energy proton flux (greater than 10 MeV) is expected to remain at Background levels. The high energy electron flux (greater than 2 MeV) is expected to continue fluctuating between Moderate and High until at least Day 2 (30th), followed by a drop in electron flux to more persistently Moderate or Background levels. Corresponding electron fluence is expected to remain above the Active (1e8 integrated pfu) fluence level until at least Day 2. After this it may lower to Moderate levels, though confidence in the timing of this occurring is medium.

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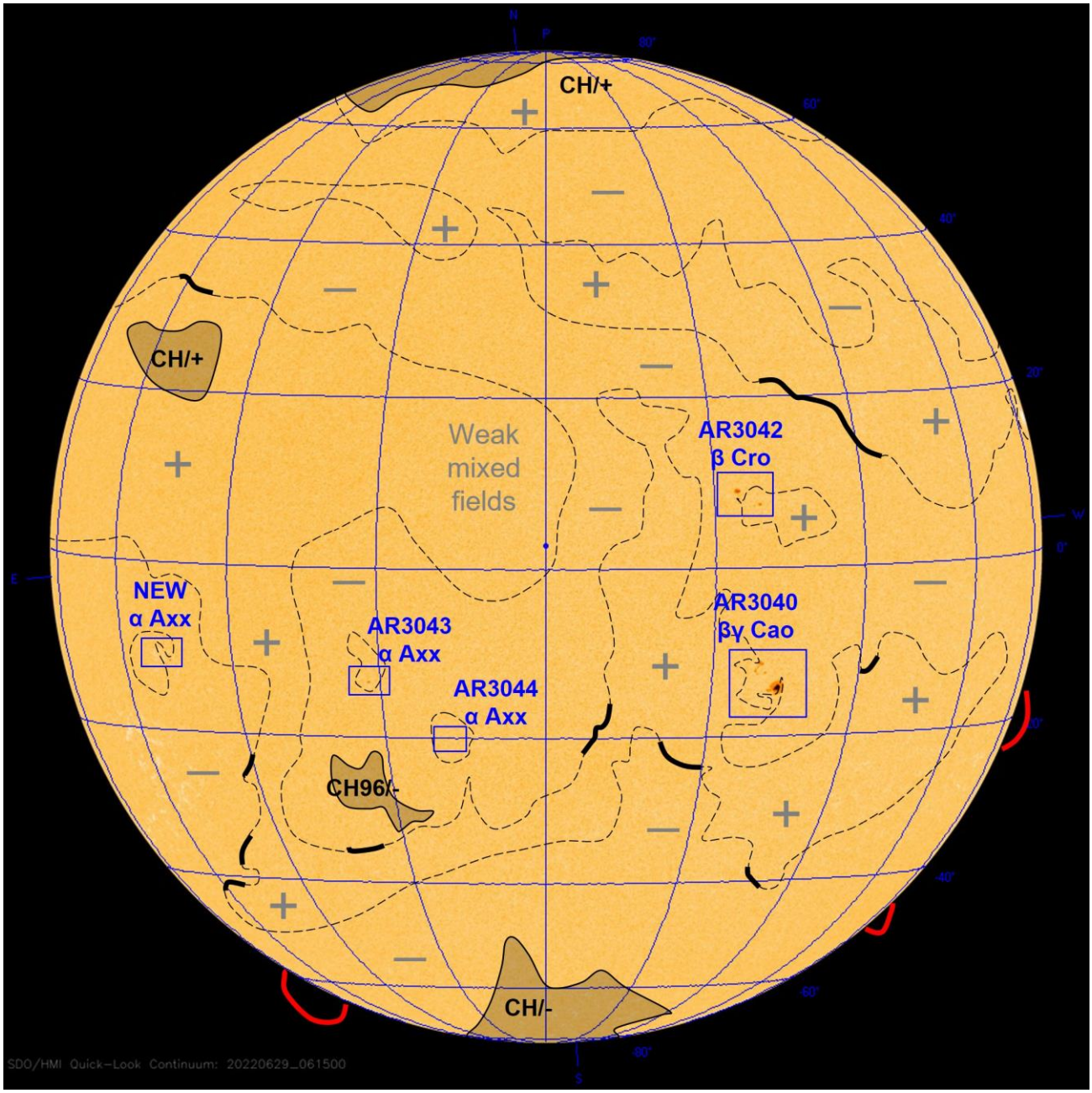
Figure 1. Solar Analysis Valid 29/0800 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A CME which left the Sun on the 26th may arrive at Earth on the 2nd July (Day 4). However its velocity is estimated to be slow, so much so that it will most certainly be unnoticed when reaching the Earth, merging with the background solar wind. Little if no impact on the geomagnetic activity. Another CME was observed leaving the sun at around 28/2200 UTC, this time originating from a filament lift-off in the northern centre disc. The results of the analysis are not fully known yet but it is considered to be slow and to arrive at Earth beyond the validity period of this forecast, most likely on Day 6 (04th). No other earth-directed CMEs currently feature in the forecast.

The solar wind has recently started to decline otherwise, currently around 490km/s, as the connection with the HSS originating from CH93/- and CH94/- subsides. With no other coronal features visible in the western hemisphere, solar winds should continue to ease towards slow-ambient levels, as suggested by the Solar Wind Persistence Model. Geomagnetic activity is expected to be mainly Quiet with isolated Unsettled intervals.

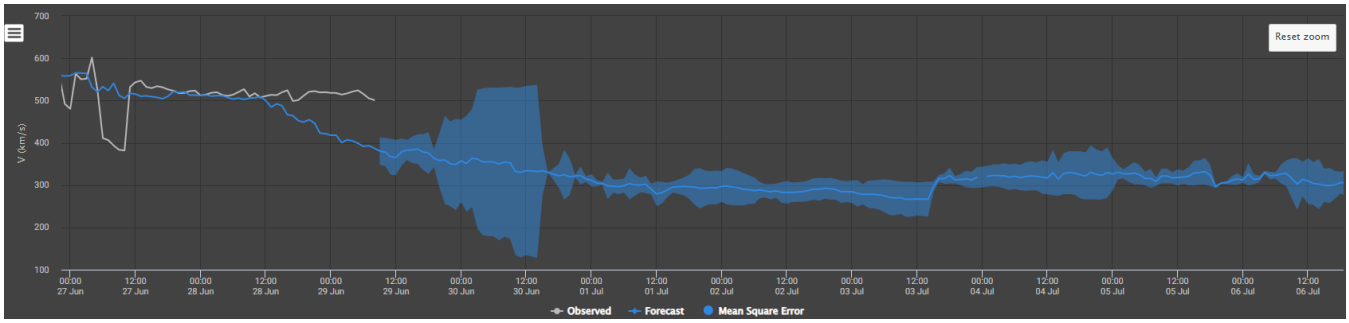
A large filament is visible in the northwest quadrant. It is currently stable but will need to be monitored for any potential lift off.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	1	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
27/1714	Partial	Filament eruption	Centre disc	242 km/s	02/1200 UTC +/- 12hrs	Little shock expected

Figure 2: Solar Wind Persistence Model, considered to give good guidance



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Radio Blackouts - X-Ray Flares:

Solar activity has been Very Low over the past 24 hours, with no significant flares observed. There are five sunspot regions on the visible disc. AR3040 remains the largest region and although it appears largely inactive, a couple of spots have developed to the north of the main leader, from both positive and negative polarity. The group is now considered as Cao/Beta-Gamma. AR3041 has now rotated off the visible disc and has been removed from analysis. The other regions are small and unipolar groups.
Activity is expected to remain Low or Very Low, with only a slight chance of isolated M-flares.

A bright flux region is visible on STEREO-EUVI imagery (around N20 E110), perhaps indicating the presence of an active region. This would be expected to rotate onto the Earth-facing disc on Day 2 or 3 (30th June or 1st July).

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	10	5	5	5
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: Latest GOES X-Ray flux

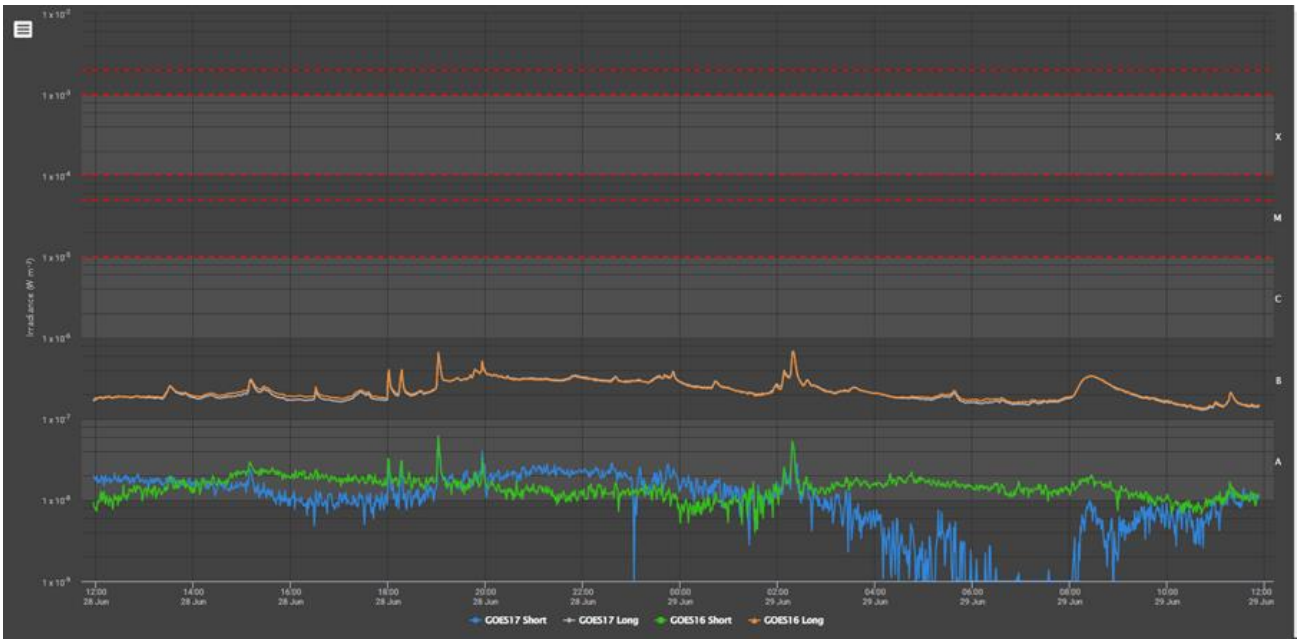

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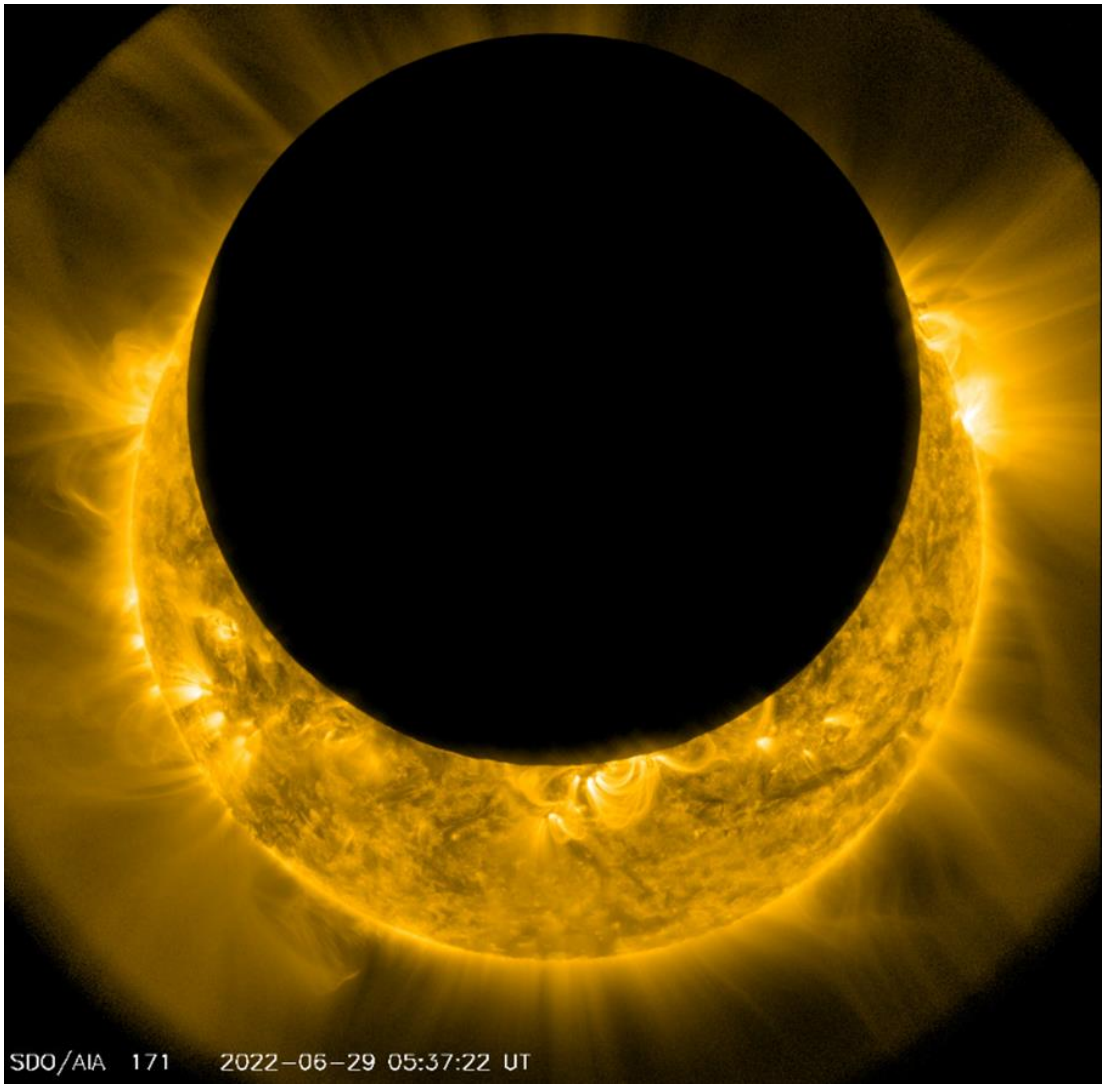
Figure 3: Partial solar eclipse, as viewed by SDO at 29/0537 UTC



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is currently at Background levels, and will most likely remain at this level through the period, in the absence of any significant sunspot development.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons Event (≥ 2MeV):
The High energy electron flux (greater than 2MeV) was High initially, peaking at 4930 pfu at 28/1515 UTC, but dropped after 28/2200 UTC, fluctuating erratically between moderate and high levels. It's now on the rise, back to High levels.

Electron flux levels are expected to continue fluctuating between Moderate and High until at least Day 2 (30th), reaching its peak in the late afternoon or early evening. Beyond that, a drop in electron flux to more persistently Moderate or Background levels appears more probable. Corresponding electron fluence is expected to remain above the Active (1e8 integrated pfu) fluence level until at least Day 2. After this it may lower to Moderate levels, though confidence in the timing of this occurring is medium. Active levels of fluence were observed around 24 hours later than standard 27-day persistence had indicated, though this and the REFM forecast indicate fluence levels remaining above the Active threshold well into Day 2 and perhaps into Day 3. This gives added confidence to the current forecast.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	90	50	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	5	1	1	1

Figure 4: Latest GOES-16 High Energy Electron flux

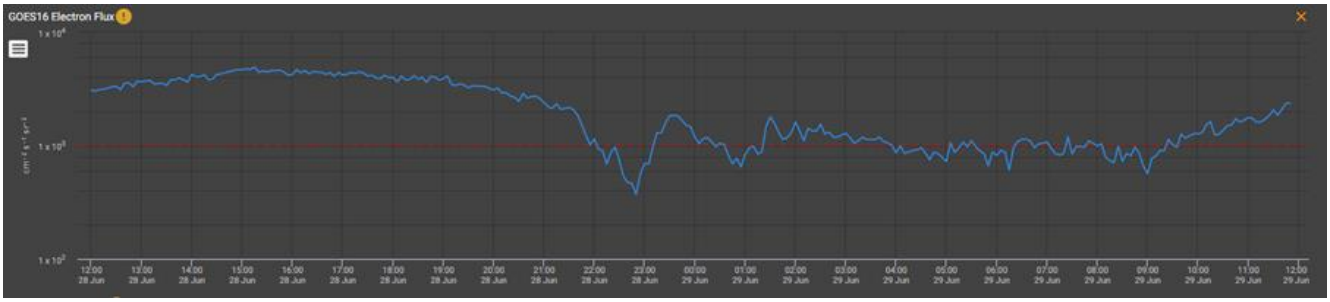

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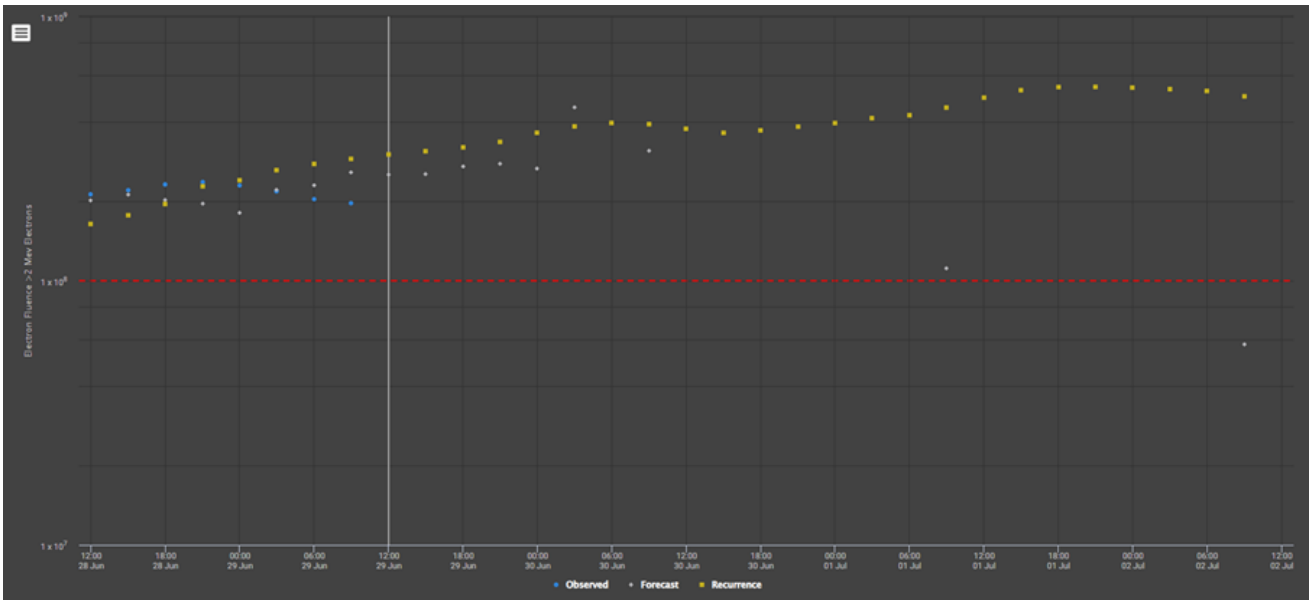
Figure 4: Latest REFM output, considered to give good guidance



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